

RF design of the $\beta0.35$ spoke cavity “AMANDA”



Guillaume OLRY
Institut de Physique Nucléaire
olry@ipno.in2p3.fr

Introduction

European projects

- **XADS** (Transmutation) : CW, I=10 mA (\rightarrow 40 mA), E=600 MeV (\rightarrow 1 GeV)
- **EURISOL** (Radioactive ions beams) : CW, I=5 mA, E=1 GeV (\rightarrow 2 GeV)

Study of spoke cavities

$$5\ldots10 \text{ MeV } (\beta_p \sim 0.1) < E_{\text{proton}} < 80\ldots100 \text{ MeV } (\beta_p \sim 0.5)$$

IPHI injector

ECR source + RFQ

Elliptical cavities

5-cell, 700MHz

RF design

Main parameters

- Frequency: 352 MHz
 - IPHI frequency
 - Large beam tube aperture
- 2-gap cavity
 - Fabrication cost
 - Higher energy acceptance/multi-gap cavities
- $\beta_g = 0.35$
 - Transition with $\beta_0 = 0.47$ elliptical cavities (~ 85 MeV)

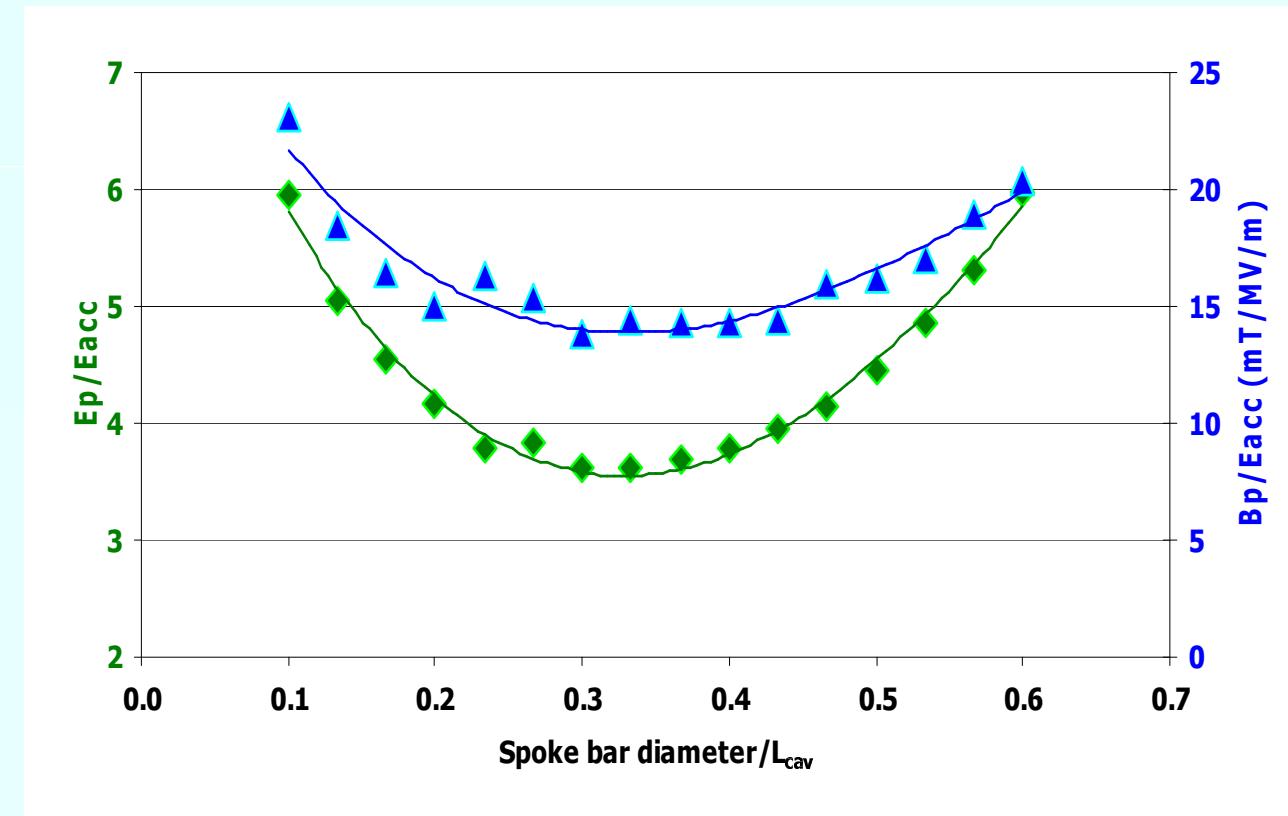
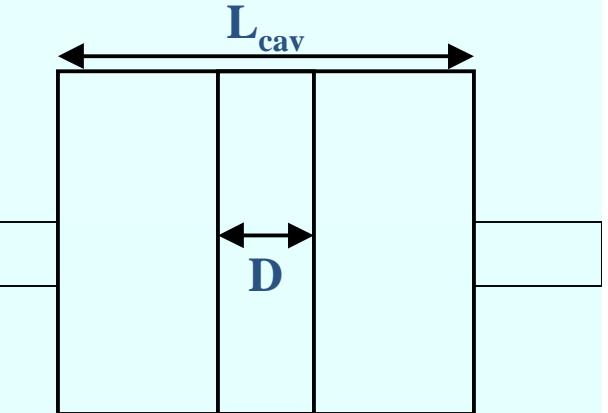
Geometry optimization

- Many parameters
 - Spoke bar shape (base & center)
 - End walls
- Minimize E_p/E_{acc} & B_p/E_{acc}
- Maximize E_{acc} and T
- “Simple” final geometry
 - Feasibility
 - Fabrication cost

RF design

Starting point: pillbox cavity with **cylindrical spoke bar**

- Variation of the spoke bar diameter (L_{cav} fixed)
- $L_{cav}=300$ mm, Cavity diameter=300 mm

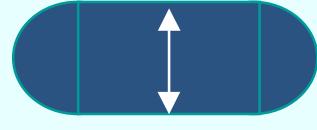


Minimum
for
 $D/L_{cav} = 1/3$

RF design

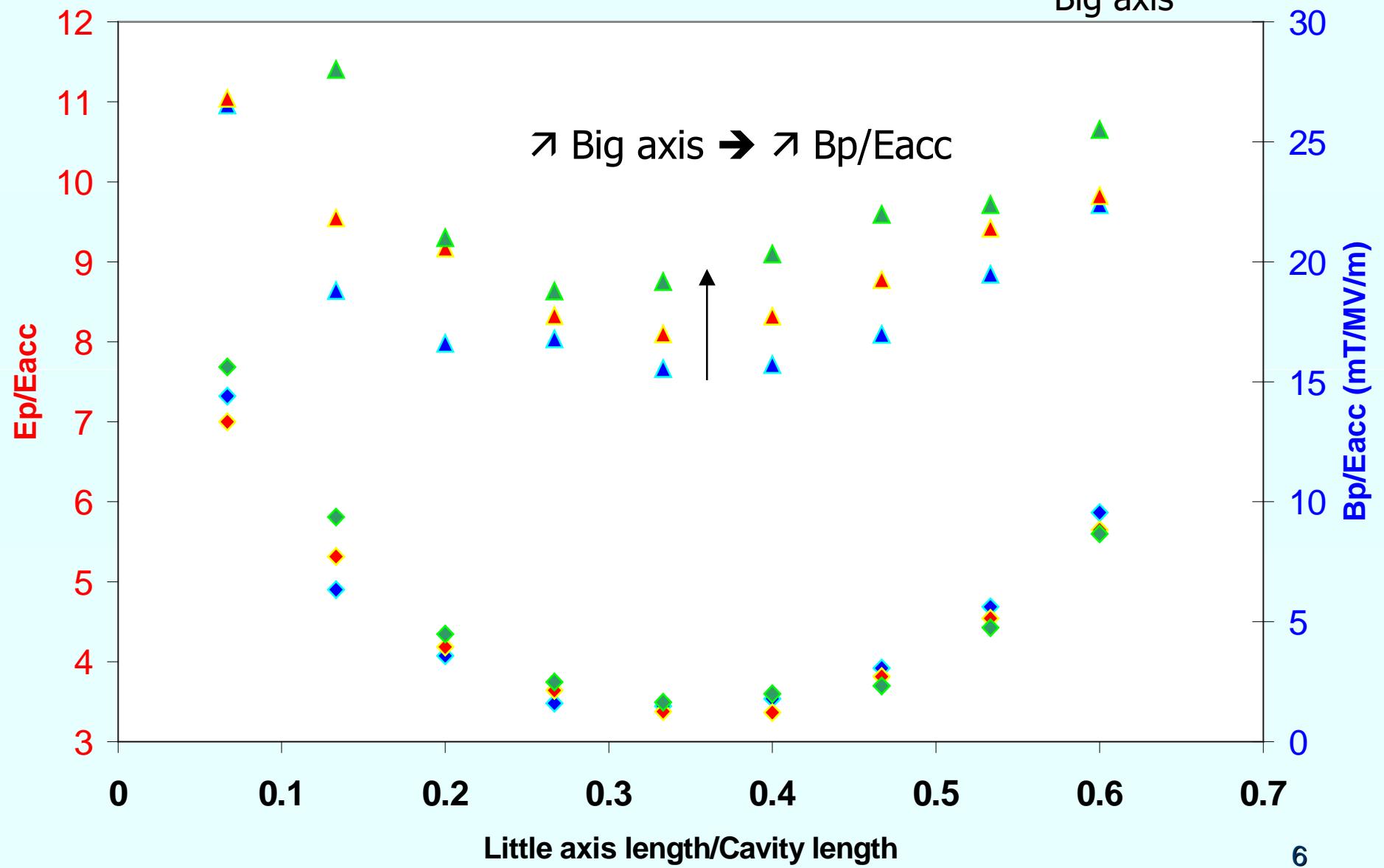
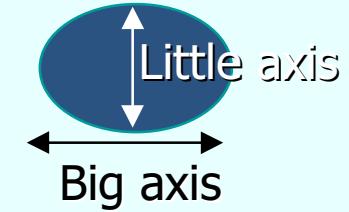
Comparison : cylindrical, elliptical and racetrack spoke bar shape

- Mesh points : 1 000 000, mesh size : 2 mm

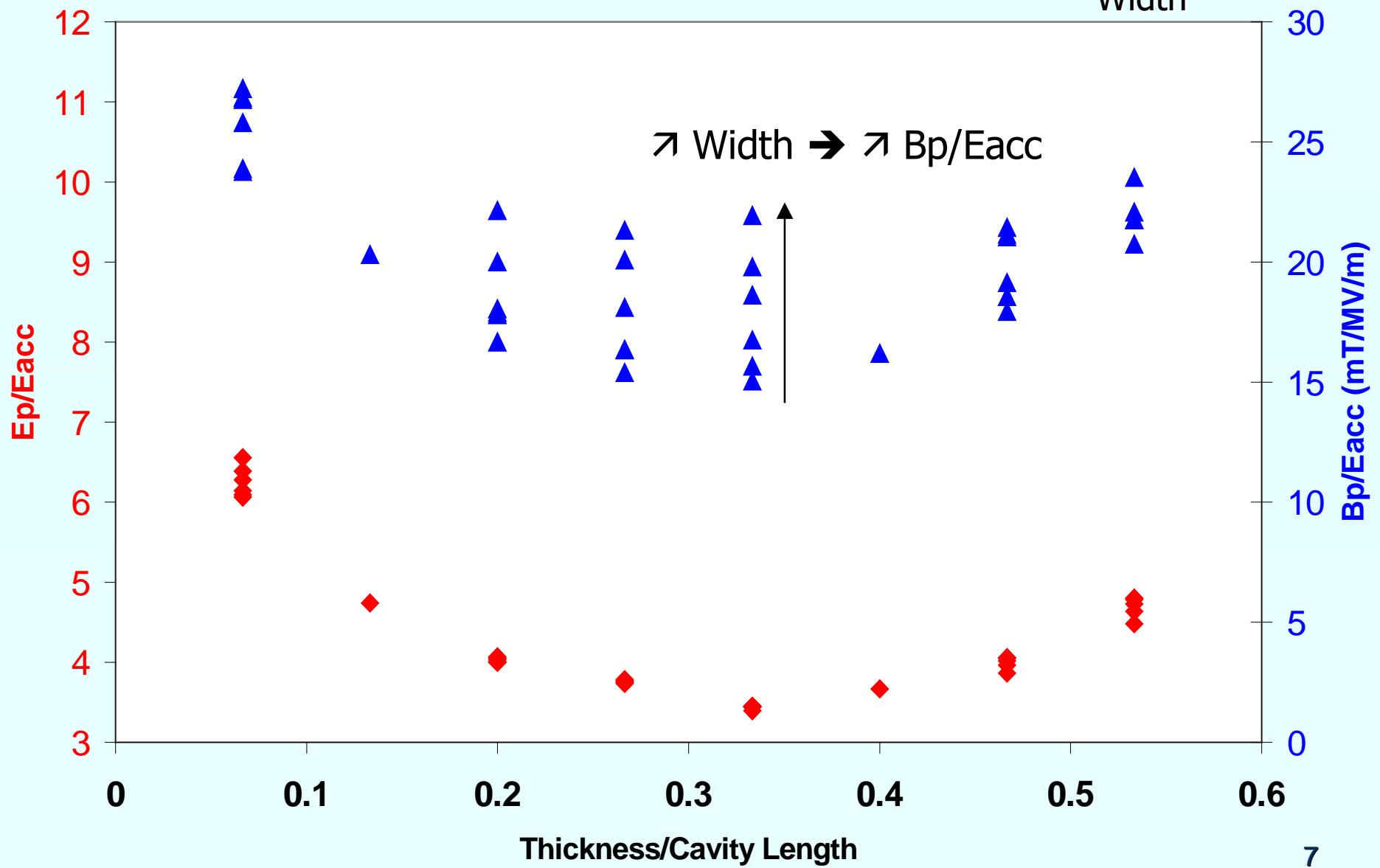
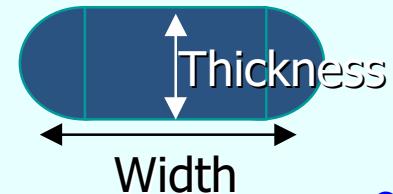
| | Ep/Eacc | Bp/Eacc (mT/MV/m) |
|---|---------|----------------------|
|  | 3.60 | 13.8 |
|  | 3.40 | 15.5 |
|  | 3.40 | 15.0 |

Minimum
for
 $D/L_{cav} = 1/3$

Elliptical spoke bar



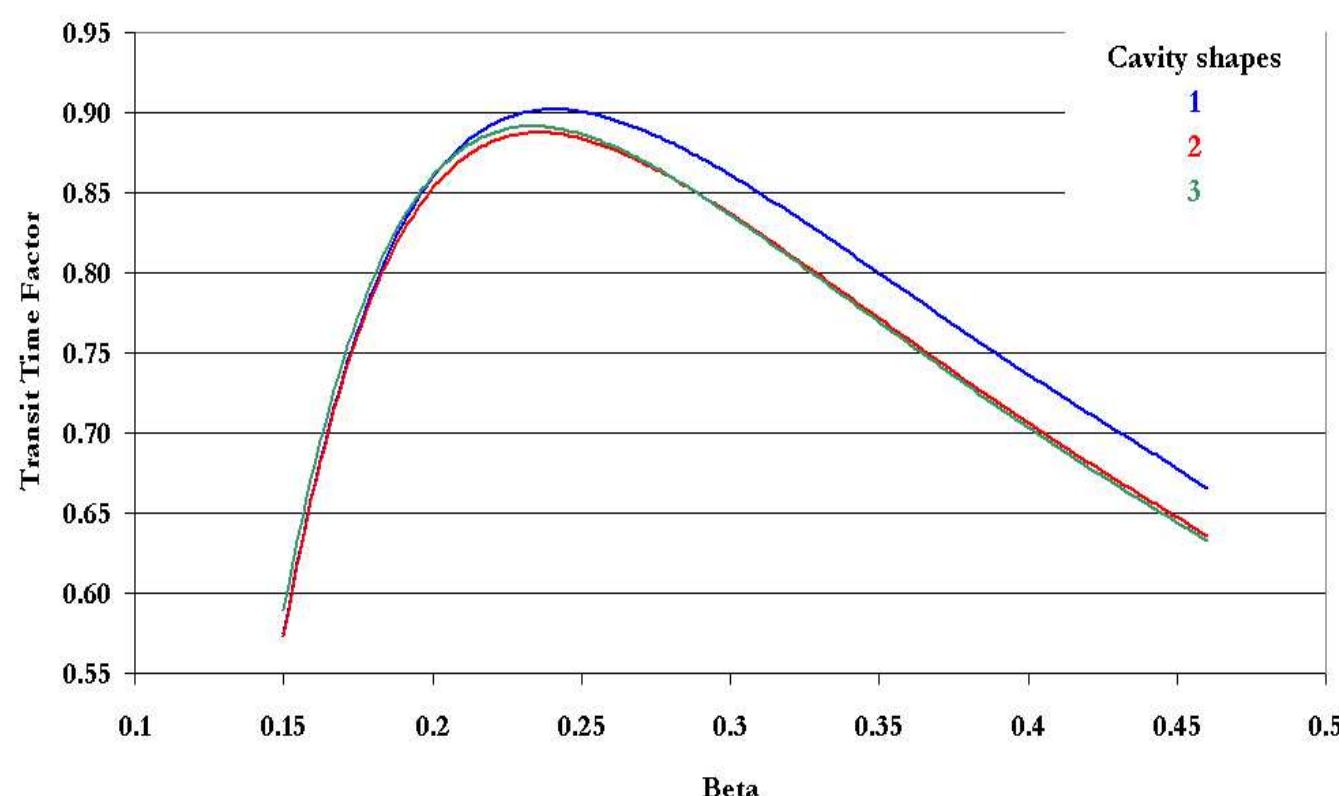
Racetrack spoke bar

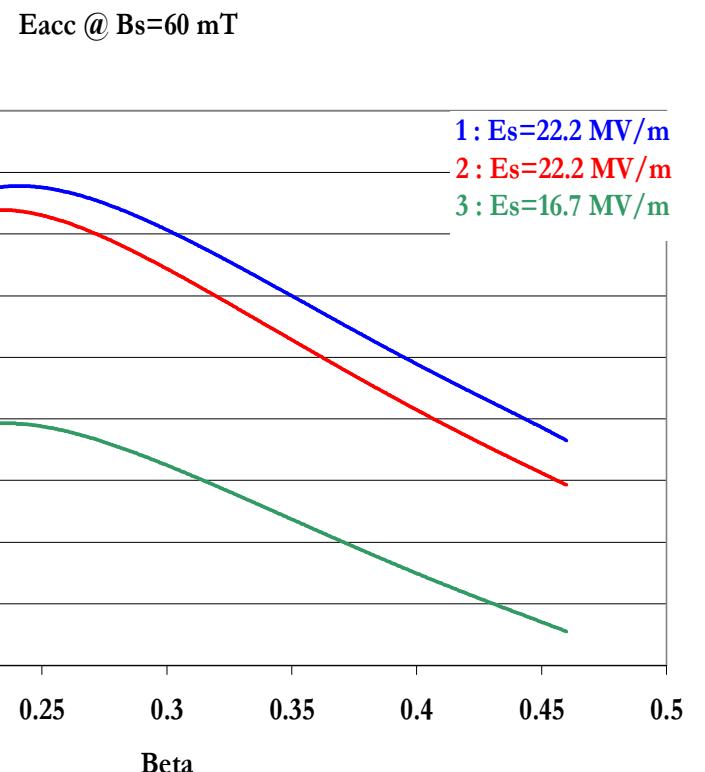
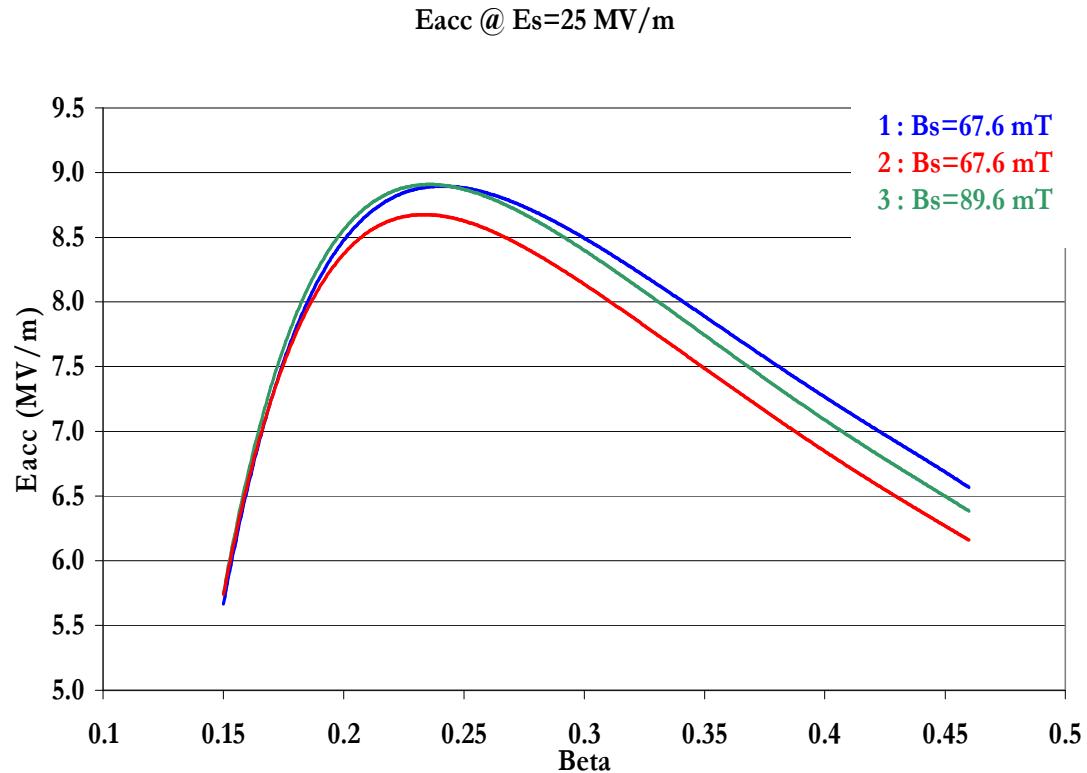


RF design

Comparison : 3 types of cavity ($f=320$ MHz, $\beta_g 0.24$)

- 1 Cylindrical spoke base + racetrack spoke center & reentrant end walls
- 2 Cylindrical spoke bar & reentrant end walls
- 3 Pillbox with cylindrical spoke bar





Conclusion

Best design

Cylindrical spoke base + racetrack spoke center & reentrant end walls

RF parameters

| | |
|-------------------------------------|--------|
| Frequency (MHz) | 358.66 |
| R_s @ 4K ($n\Omega$) | 53 |
| r/Q (Ω) | 220 |
| G (Ω) | 101 |
| E_s/E_{acc} | 3.06 |
| B_s/E_{acc} (mT/MV/m) | 8.28 |
| E_{acc} @ $E_s=25$ MV/m (MV/m) | 8.18 |
| Voltage gain (MV) | 1.64 |
| Optimum beta | 0.36 |

Residual resistance=10 $n\Omega$

$L_{acc}=200$ mm

